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(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2001－61261
（Ｐ２００１－６１２６１Ａ）
(43)公開日　平成13年３月６日(2001.3.6)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
H02K 15/03		H02K 15/03	Z	
			G	
C25D 7/00		C25D 7/00	K	
H02K 1/27	501	H02K 1/27	501 Z	
15/12		15/12	C	

審査請求　有　請求項の数10　ＯＬ　（全９頁）

(21)出願番号　特願2000－227099（Ｐ2000－227099）
(62)分割の表示　特願平8－500635の分割
(22)出願日　平成７年３月31日(1995.3.31)
(31)優先権主張番号　特願平6－120388
(32)優先日　平成６年６月１日(1994.6.1)
(33)優先権主張国　日本（ＪＰ）
(31)優先権主張番号　特願平6－233224
(32)優先日　平成６年９月28日(1994.9.28)
(33)優先権主張国　日本（ＪＰ）
(31)優先権主張番号　特願平6－255791
(32)優先日　平成６年10月20日(1994.10.20)
(33)優先権主張国　日本（ＪＰ）

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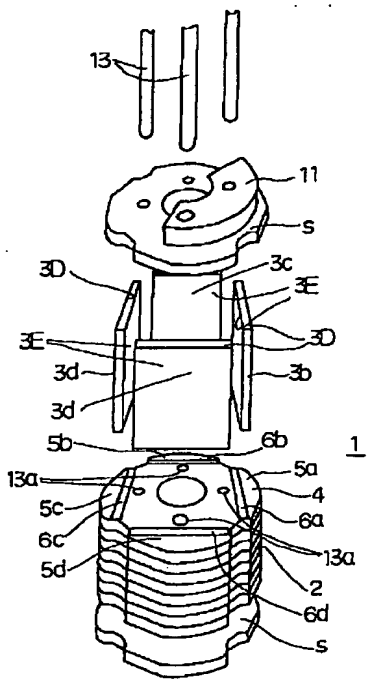
(54)【発明の名称】永久磁石回転子及びその製造方法

(57)【要約】
【課題】　電気メッキを施した界磁用永久磁石を用いる場合に、メッキ層が界磁用永久磁石の中央部と端部でほぼ均一でかつ電極跡がなく、しかも工程の簡易化及び製造時間の短縮化を図り得る永久磁石回転子及びその製造方法を得ること。
【解決手段】　回転子（１）のヨーク（２）は多数の鋼板（４）を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極（５）を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロット（６）を備え、このスロットには予め電気メッキ（Ｍ１）が施された界磁用永久磁石（３）を挿入してなる永久磁石回転子及びその製造方法において、界磁用永久磁石は、電気メッキが施されるにあたり、永久磁石に導通する電極と当該永久磁石とが、相対的に移動するようにした。



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【特許請求の範囲】

【請求項１】　回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、

前記界磁用永久磁石は、前記電気メッキが施されるにあたり、永久磁石に導通する電極と当該永久磁石とが、相対的に移動することを特徴とする永久磁石回転子の製造方法。

【請求項２】　回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、

前記界磁用永久磁石は、前記電気メッキが施されるにあたり、永久磁石に導通する電極が複数存在するとともに、前記複数の電極を、当該永久磁石に対し択一的に接触させるようにしたことを特徴とする永久磁石回転子の製造方法。

【請求項３】　回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、

回転軸にロータヨークを挿着するにあたり、ロータヨークのスロットに希土類の界磁用永久磁石を挿入した後、界磁用永久磁石の前記キューリー点の温度以上であって、界磁用永久磁石の素材の性能維持温度未満の温度の間でロータヨークを加熱した後、このロータヨークを回転軸に挿着し、その後、着磁することを特徴とする永久磁石回転子の製造方法。

【請求項４】　回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、

前記電気メッキのメッキ層の厚さが界磁用永久磁石の中央部と端部でほぼ均一で且つ電極跡がない電気メッキが前記界磁用永久磁石に施された後、前記界磁用永久磁石を挿着したロータヨークを、前記界磁用永久磁石のキューリー点より高い温度に加熱したことを特徴とする永久磁石回転子の製造方法。

【請求項５】　前記電気メッキの材質がニッケルメッキであることを特徴とする請求項１、２又は４記載の永久磁石回転子の製造方法。

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【請求項６】　回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施されて、冷媒中で使用される界磁用永久磁石を挿入してなる永久磁石回転子において、

前記電気メッキのメッキ層の厚さが、平板状の界磁用永久磁石の中央部と端部でほぼ均一で且つ電極跡がない電気メッキが前記界磁用永久磁石に施されていることを特徴とする永久磁石回転子。

【請求項７】　前記電気メッキの材質がニッケルメッキであることを特徴とする請求項６記載の永久磁石回転子。

【請求項８】　前記電気メッキのメッキ層の厚さが、界磁用永久磁石のほぼ中央部で、５μｍ以上２０μｍ以下、更に好ましくは５μｍ以上１０μｍ以下であることを特徴とする請求項６記載の永久磁石回転子。

【請求項９】　回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、無電解ニッケルメッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、

前記界磁用永久磁石は希土類磁石であって、前記ニッケルメッキの熱処理を、無電解ニッケルメッキが施された界磁用永久磁石をロータヨークの前記スロットに挿着した後に行うことを特徴とする永久磁石回転子の製造方法。

【請求項１０】　前記熱処理温度が、３５０～４００℃であることを特徴とする請求項９記載の永久磁石回転子の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、ロータヨークの磁極の全磁極又は１つおきの基部に界磁用永久磁石を挿入するようにした永久磁石回転子及びその製造方法に関する。

【０００２】

【従来の技術】一般に、コンプレッサにおいて、冷媒とオイルが流通する密閉容器の内部に、駆動モータと圧縮装置とを直列的に配置し、前記駆動モータの回転子に界磁用永久磁石が挿着されている技術が知られている。

【０００３】図９は、従来の冷凍サイクル用コンプレッサの縦断面を示している。全体を符号５００で示す冷凍サイクル用コンプレッサは、冷媒が流通する密閉容器５１０を有している。この容器５１０の内部には、圧縮装置（図示を省略）と駆動モータ５２０とが上下直列に配置されている。

【０００４】駆動モータ５２０は、回転子７００、固定子６００及び回転軸７１０とから構成されている。前記

固定子６００は、固定子鉄心６１０と励磁用コイル６２０とから構成される。前記回転子７００は、ロータヨーク７２０、界磁用永久磁石７３０、スペーサ７４０及びバランスウエイト７５０を有している。ロータヨーク７２０は、多数のけい素鋼板７６０を積層することによって形成されている。ロータヨーク７２０の外周には磁極７７０が設けられており、この磁極７７０の基部には、界磁用永久磁石７３０を挿入するスロット７８０が設けられている。

【０００５】界磁用永久磁石７３０はスロット７８０に収容可能な大きさに形成されており、界磁用永久磁石の表面には一般に表面処理が施されていないものである。

【０００６】冷凍サイクル用コンプレッサの組立に際しては、予め密閉容器５１０に設置された回転軸７１０に、ロータヨーク７２０が焼き嵌め挿入される。すなわち、ロータヨーク７２０を約４５０℃に加熱して、中心の回転軸孔を膨張させて若干大径となし、熱いまま回転軸７１０に挿入する。その後ロータヨーク７２０が冷却すると、膨張していた回転軸孔が収縮し、当該貫通孔が回転軸７１０を緊締保持することとなる。尚、コンプレッサ使用時には、コンプレッサ自体の温度が上昇して、約１３０℃に達するが、この場合は回転軸７１０も同時に膨張するので、回転軸７１０に対するロータヨーク７２０の保持が減じられることはない。

【０００７】そして、界磁用永久磁石７３０がロータヨーク７２０に挿入される。すなわち、ロータヨーク７１０の冷却後に、防錆紙に包まれた無着磁で表面処理のされていない界磁用永久磁石７３０がスロット７８０の内部に挿入される。更に、界磁用永久磁石７３０の挿入後、界磁用永久磁石の軸方向の固定として、非磁性のスペーサ７４０がロータヨーク７２０の端部まで圧入され、次いで、圧縮装置の動バランスをとる磁性のバランスウエイト７５０が、スペーサ７４０端部近傍まで圧入される。図中矢印Ｑは界磁用永久磁石７３０の挿入方向を示している。

【０００８】前記各部品が挿着された後、密閉容器５１０の蓋（図示を省略）が閉められ、そして、励磁用コイル６２０に高電流を流し、回転軸７１０をロックして界磁用永久磁石７３０が着磁され、その後、密閉容器５１０の内部に温風を吹きかけて乾燥させ、内部水分を蒸発させるものである。

【０００９】

【発明が解決しようとする課題】前述した従来技術によると、表面処理のされていない界磁用永久磁石をロータヨークのスロットに挿入するものであるため、界磁用永久磁石を組込むまでのサビの発生防止の管理が以外と大変であり、また、スロット挿着後も、冷媒とオイルが加圧され流通する圧力容器中でモータが作動するので、界磁用永久磁石の素材の内部まで冷媒及びオイルが浸透して、磁石が溶解される問題があった。そこで、近時は、コンプレッサに使われる界磁用永久磁石に表面処理のなされるものが知られている。この場合の表面処理は、磁石単品の対向する２面を針状の固定電極で挟み、これに電流を流して、メッキ槽に浸漬してニッケルメッキが施されるが、磁石素材表面の固定電極が接した部分にはメッキがつかないため、磁石素材が露出する。

【００１０】このような電気ニッケルメッキが施された界磁用永久磁石をロータヨークのスロットに挿入する場合は、電極跡から錆が発生することを防止するため、電極跡に補修材を塗布する必要があり（電極跡に補修材を塗布したものを、以下、電極跡つきニッケルメッキとも称する。）、更に、このような補修を行っても、補修材が冷媒又はオイルに解ける問題があった。加えて、焼き嵌め及び温風乾燥の高温に対して、補修材とメッキとの膨張係数の違いにより、補修材の剥がれが生じ易く、また、材質の違いにより耐熱強度の低下もあって、補修部を含めた磁石の寸法管理も大変であった。

【００１１】更に、電極跡つきニッケルメッキは、固定電極のため、メッキ電流が界磁用永久磁石の端部に集中して、一般に端部が中央部より厚くなる傾向（２０μｍ～５０μｍ増）があり、従って寸法管理が難しいと同時に、メッキ膜が厚くなると、膜中の残留応力が増大するため、密着力も低下する不都合があった。

【００１２】他方、前述した電気メッキを施した界磁用永久磁石を用いるのでなく、無電解メッキを施した界磁用永久磁石をロータヨークに挿入するものも存在する。この場合は、無電解メッキを施した界磁用永久磁石の熱処理を別途に行い、ロータヨークを回転軸に焼き嵌め挿入した後に、熱処理後の界磁用永久磁石をロータヨークのスロットに挿着している。このような無電解メッキを施した界磁用永久磁石を用いる場合は、無電解メッキを施した界磁用永久磁石の熱処理、ロータヨークの回転軸への焼き嵌め挿入、及び、その後の界磁用永久磁石のロータヨークのスロットへの挿着、という３つの工程を採っているため、工程時間が長くなるとともに、磁石の固定が難しいという問題がある。

【００１３】本発明は、電気メッキを施した界磁用永久磁石や、無電解メッキを施した界磁用永久磁石が、ロータヨークのスロットに挿着されている永久磁石回転子及びその製造方法を改良して、電気メッキを施した界磁用永久磁石を用いる場合は、メッキ層が界磁用永久磁石の中央部と端部でほぼ均一でかつ電極跡がなく、また、無電解メッキを施した界磁用永久磁石を用いるものともども、工程の簡易化及び製造時間の短縮化を図り得る永久磁石回転子及びその製造方法を得ることにある。

【００１４】

【課題を解決するための手段】請求項１記載の発明は、回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロット

を備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、前記界磁用永久磁石は、前記電気メッキが施されるにあたり、永久磁石に導通する電極と当該永久磁石とが、相対的に移動する永久磁石回転子の製造方法である。

【００１５】請求項２記載の発明は、回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、前記界磁用永久磁石は、前記電気メッキが施されるにあたり、永久磁石に導通する電極が複数存在するとともに、前記複数の電極を、当該永久磁石に対し択一的に接触させるようにした永久磁石回転子の製造方法である。

【００１６】請求項３記載の発明は、回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、回転軸にロータヨークを挿着するにあたり、ロータヨークのスロットに希土類の界磁用永久磁石を挿入した後、界磁用永久磁石の前記キューリー点の温度以上であって、界磁用永久磁石の素材の性能維持温度未満の温度の間でロータヨークを加熱した後、このロータヨークを回転軸に挿着し、その後、着磁する永久磁石回転子の製造方法である。

【００１７】請求項４記載の発明は、回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、前記電気メッキのメッキ層の厚さが界磁用永久磁石の中央部と端部でほぼ均一で且つ電極跡がない電気メッキが前記界磁用永久磁石に施された後、前記界磁用永久磁石を挿着したロータヨークを、前記界磁用永久磁石のキューリー点より高い温度に加熱した永久磁石回転子の製造方法である。

【００１８】請求項５記載の発明は、請求項１、２又は４の発明において、前記電気メッキの材質がニッケルメッキである永久磁石回転子の製造方法である。

【００１９】請求項６記載の発明は、回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、予め電気メッキが施されて、冷媒中で使用される界磁用永久磁石を挿入してなる永久磁石回転子において、前記電気メッキのメッキ層の厚さが、平板状の界磁用永久磁石の中央部と端部でほぼ均一で且つ電極跡がない電気メッキが前記界磁用永久磁石に施されている永久磁石回転子である。

【００２０】請求項７記載の発明は、請求項６の発明において、前記電気メッキの材質がニッケルメッキである永久磁石回転子である。

【００２１】請求項８記載の発明は、請求項６の発明において、前記電気メッキのメッキ層の厚さが、界磁用永久磁石のほぼ中央部で、５μｍ以上２０μｍ以下、更に好ましくは５μｍ以上１０μｍ以下である永久磁石回転子である。

【００２２】請求項９記載の発明は、回転子のヨークは多数の鋼板を積層して形成され、外周上に２ｎ倍（ｎは正整数）の磁極を有し、回転軸孔からほぼ等しい距離の全磁極又は１つおきの基部にスロットを備え、このスロットには、無電解ニッケルメッキが施された界磁用永久磁石を挿入してなる永久磁石回転子の製造方法において、前記界磁用永久磁石は希土類磁石であって、前記ニッケルメッキの熱処理を、無電解ニッケルメッキが施された界磁用永久磁石をロータヨークの前記スロットに挿着した後に行う永久磁石回転子の製造方法である。

【００２３】請求項１０記載の発明は、請求項９の発明において、前記熱処理温度が、３５０～４００℃である永久磁石回転子の製造方法である。

【００２４】

【発明の実施の形態】以下、本発明の実施例について添付の図面を参照して説明する。

【００２５】図１は、本発明の実施例に係る永久磁石回転子を示す分解図である。本実施例の永久磁石回転子１は、柱状に積層されたロータヨーク２と、二対の板状の界磁用永久磁石３（３ａ，３ｂ，３ｃ，３ｄ）とを有している。前記ロータヨーク２は、多数のけい素鋼板４を金型で抜きかつ一体に積層して形成されている。ロータヨーク２は、外周面に放射方向に突出した４つの磁極５（５ａ，５ｂ，５ｃ，５ｄ）を有している。これら磁極の基部には、界磁用永久磁石を挿着させるスロット６（６ａ，６ｂ，６ｃ，６ｄ）が設けられている。更に、ロータヨーク２の中心部には、回転軸を貫通させる回転軸孔が設けられている。また、スロットと回転軸孔との最短距離の間に、界磁用永久磁石の軸方向の固定用リベット貫通孔１３ａが設けられている。

【００２６】界磁用永久磁石３ａ，３ｂ，３ｃ，３ｄは、図２の（ａ）に示すように、断面矩形の６面体に形成され、界磁用永久磁石の表面には、電気ニッケルメッキＭ１を施している。この電気ニッケルメッキＭ１は、後述するメッキ手段によりメッキが施される。

【００２７】更に、界磁用永久磁石３をスロット６に挿入し、当該界磁用永久磁石の軸方向の固定として、非磁性のスペーサｓをロータヨーク２の両端に設置させ、圧

縮装置の動バランスをとるバランスウエイト１１を被せ、最後にロータヨーク２、スペーサｓ及びバランスウエイト１１をまとめてリベット１３で全体をかしめて固定する。これにより、本実施例の永久磁石回転子１が組み立てられる。

【００２８】本発明において、前記電気ニッケルメッキは、メッキの皮膜厚が、図２の（ｂ）に示す界磁用永久磁石３の中央部３Ａと、図２の（ｃ）に示す端部３Ｂとでほぼ均一で、且つ、電極跡がない電気メッキである。

【００２９】このような電気ニッケルメッキＭ１は、例えば図３に示すようにしてメッキが施される。すなわち、溶液８０２を充填した容器８０１内に、その上面が傾斜面８０４をなす治具８０３を設置し、この治具８０３の近傍に一対の球状の電極８０５，８０５を配置してメッキ装置８００を構成する。磁石３は、前記傾斜面８０４にセットされて斜下方に送られると、溶液８０２内で磁石３が電極８０５，８０５に挟持されるとともに、当該電極が回転して、磁石３は更に下方に送られる。電極８０５，８０５は回転するもその位置を保持し、この電極８０５，８０５にメッキ電源が導通されて磁石３に電気ニッケルメッキがなされる。このとき、磁石３の電極位置が変るので、磁石３の表面に万遍なくニッケルメッキを施すことができる。更に、電極が球状であるため、磁石に対して点接触となり、メッキ厚みにバラツキを生じることが少なくなる。

【００３０】発明者等の実験によれば、前述したように電極を移動させて電気ニッケルメッキを行うことにより、界磁用永久磁石３の中央部３Ａと端部３Ｂとがほぼ均一で且つ、電極跡のない電気メッキが得られることを確認している。とりわけ、鋭角の角部を保持している界磁用永久磁石において、角部が丸くならずに、均一に磁石素材の形状に沿ってメッキを施すことができた。尚、本実施例でニッケルメッキとしているのは、これにより高い硬度のメッキ層を得ることができ、摩耗しにくく疵の付きにくい表面となるからである。もっとも、本発明はニッケルメッキに限られるものでないことは勿論である。

【００３１】本実施例において、メッキ層は、図４に示すように、５～２０μｍが好ましい。更に、特に好ましいのは５～１０μｍである。図４において、横軸は磁石の長手方向の間隔であって、ｔが端部、ｔ／２が中央部であり、また、縦軸は、メッキ層の厚みを示している。

【００３２】界磁用永久磁石に施されるメッキ層は、薄いほどよい。これは、メッキ層が厚くなると、界磁用永久磁石とけい素鋼板との間のギャップが大きくなって磁束の効率が悪くなるし、熱膨張や熱応力によりメッキ層の割れや剥れを生じてしまう。この点、メッキ層の薄い方が受ける熱応力が少なくてすみ、歪を小さくすることができるので、薄い方がよい。しかし、５μｍ未満であると、振動に対する強度が不足し、例えばコンプレッサに用いられるモータの場合は、コンプレッサの運転範囲（－２０～１３０℃）でメッキ層が剥がれてしまう不都合を生じる。他方、２０μｍを超えると、熱膨張や熱応力によりメッキ層の割れや剥れを生じることが判明している。従って、前述したように、メッキ層は、５～２０μｍが好ましい。とりわけ、メッキ層を５～１０μｍとした場合は、磁石をコンプレッサ組み込み後に強制冷却しても、メッキ層の割れは生じない。強制冷却しないときは、５～２０μｍでよい。

【００３３】図５は、本発明に用いる他の電気メッキ装置を示す図で、この例の場合は、溶液８０２を充填した容器８０１内に、ローラ状の治具８０３，８０３を設置し、この治具８０３に沿って横方向に移動可能な一対のロール状の電極８０５，８０５を配置してメッキ装置８００を構成する。電極８０５，８０５はスライダ８０６に支持杆８０７を介して横方向に移動可能に設けられている。磁石３は、溶液８０２内に浸漬され且つ前記治具８０３，８０３に載置されて、電極８０５，８０５に挟持される。この例では、電極８０５，８０５が回転して横方向に移動し、磁石３に電気ニッケルメッキがなされる。この例でも磁石３の電極位置が変るので、磁石３の表面に万遍なくニッケルメッキを施すことができる。また、ローラ状の治具８０３，８０３は、これが磁石３を載置する際に始終同じ位置で当接するとメッキのなされない箇所を生じるので、ローラ状の治具８０３，８０３は若干の正逆回動するようになされている。これにより、磁石３は左右方向に揺動し、前記電極８０５，８０５の磁石に対する電極位置が変ることにより、磁石３の表面にニッケルメッキがほぼ均一で、且つ、電極跡が付かずに施されることとなる。

【００３４】図６は、本発明に用いる更に他の電気メッキ装置を示す図で、この例の場合は、溶液８０２を充填した容器８０１内に、上下方向に移動可能な複数の電極８０５，８０５を設けた治具８０３を設置し、他方、横方向に移動可能な支持杆８０７の下部に、電極８０５が突設されてメッキ装置８００を構成する。磁石３は、溶液８０２内に浸漬され且つ前記治具８０３，８０３に載置され、この例では、治具８０３に設けられた電極８０５が磁石３の大きい表面積を有する面３Ｅに当接し、また、支持杆８０７に設けられた電極８０５は磁石３の小さい表面積を有する面３Ｄに当接するようにして、各電極８０５，８０５のいずれかが磁石と導通することにより、磁石３に電気ニッケルメッキがなされる。つまりこの例では、適宜択一的に電極と磁石との接触・導通が図られることにより、磁石３の電極位置が変るので、磁石３の表面に万遍なくニッケルメッキを施すことができるようになされている。

【００３５】このように、本発明においては、磁石と電極が相対的に移動するので、電気メッキの際、磁石に対する電流の集中がなくなって電極跡を生じない表面処理

がなされ、中央部及び端部に均一にメッキを施すことができる。更に、電極が移動する構成のため、鋭角の角部を備えている界磁用永久磁石に対しても、当該角部が丸くならずに均一に、磁石素材の形状に沿って、メッキ層を形成することができるものである。

【００３６】従って、従来の電気メッキによると、電極補修部が前後端面にある場合は、ロータヨーク２と磁石の軸方向の長さを同一に設定することができなかったし、また、電極補修部が磁石の大きい表面積を有する面３Ｅにある場合は、界磁用永久磁石とけい素鋼板との間のギャップを大きくしなければならず従って磁束の効率が悪くなる不都合があったのに対し、本発明によれば、界磁用永久磁石３に従来のような電極補修部の突出部がないため、このような不都合を回避することができ、その結果、寸法管理を簡単に行えるようになった。

【００３７】次に、組み立てられた本実施例の永久磁石回転子１は、界磁用永久磁石３のキューリー点から、メッキの性能維持温度又は界磁用永久磁石の素材の性能維持温度のどちらか低い温度の間で、数分以内、加熱がなされる。周知のように、磁石等の強磁性体は、それ自身自発磁気を有し、この自発磁気が外部磁界の印加により整列され、外部に磁気を顕すものであるが、この自発磁気の消滅する温度をキューリー点という。

【００３８】本実施例では、界磁用永久磁石の前記キューリー点の温度以上であって、界磁用永久磁石の素材の性能維持温度未満の温度の間で永久磁石回転子１を数分加熱した後、後述するように、この回転子１を冷凍サイクル用コンプレッサの回転軸に挿着する。

【００３９】以上説明した本実施例によれば、電気メッキの際、磁石に対する電流の集中がなくなって電極跡を生じない表面処理がなされ、中央部及び端部に均一にメッキを施すことができる。更に、電極が移動する構成のため、鋭角の角部を備えている界磁用永久磁石に対しても、当該角部が丸くならずに均一に、磁石素材の形状に沿って、メッキ層を形成することができる。特に角部３Ｃはメッキ自身の強度で保持されるため、界磁用永久磁石自身の素材強度の必要性が少なくなった。また、電気ニッケルメッキＭ１の厚みは、界磁用永久磁石のほぼ中央部３Ａにおいて、５μｍ以上２０μｍ以下の厚みとなし、界磁用永久磁石３をロータヨーク２に挿入後、界磁用永久磁石のキューリー点より高い温度で焼き嵌めすることにより、わずかに着磁された磁石が混入していても、高い温度で消磁される。更に高温をかけることにより、メッキと界磁用永久磁石との境界面の結合力が向上することも本発明者等が新しく得た知見である。また、回転軸に回転子を挿入する場合、５μｍ以上２０μｍ以下の厚みは、界磁用永久磁石とメッキとの膨張係数の違いによる歪みや割れが発生しにくい最低メッキ厚みであると同時に、ロータヨーク２のスロットに挿入後、振動によるメッキの剥がれが阻止できることも判明した。特に好ましいのは、５～１０μｍの厚みとすることであり、前述したように、強制冷却でメッキ割れを生じないものである。更に、電気メッキの材質がニッケルメッキであるため、磁石の素材より硬く、且つ軟磁性の性質を有するので、ロータヨークに挿入前後においてキズが付きにくく耐久性能も向上するものである。また、組み込み後において、仮にメッキが剥がれても、メッキは磁性体であるため、吸着されて磁石素材表面から飛散することがない。更に、本実施例のようにロータヨークのスロットに界磁用永久磁石を挿入する回転子においては、磁性体の電気メッキであるため、スロットと界磁用永久磁石との磁気ギャプを少なく設定できることも大きな利点である。

【００４０】また、界磁用永久磁石に希土類磁石を用いる場合は、次の実施例が参考になる。すなわち、ロータヨークのスロットに希土類の界磁用永久磁石を挿入した後、界磁用永久磁石の前記キューリー点の温度以上であって、界磁用永久磁石の素材の性能維持温度未満の温度の間で永久磁石回転子１を数分加熱した後、この回転子１を回転軸に挿着し、その後、着磁して、予備乾燥温度（１７０℃前後）に入る。この点、従来において、界磁用永久磁石は、モータ使用時に温度上昇して初期減磁することが知られている。ところが、希土類磁石の場合は、前記ロータヨークの回転軸への所謂焼き嵌めの際に自発磁気の消滅（減磁）がなされ、そして、その後の着磁そして予備乾燥というプロセスを経ると、将来モータが使用されて予備乾燥温度内に晒されても、前述した初期減磁という事態を回避できることが判明している。

【００４１】ところで、ニッケルメッキは、前述した電気メッキのほか、無電解メッキも知られている。そして、従来においては、無電解ニッケルメッキが施された界磁用永久磁石がロータヨークのスロットに挿着されるものも用いられている。この場合は、ニッケルメッキを施した界磁用永久磁石をロータヨークに挿着する前に、ニッケルメッキの熱処理を行っている。

【００４２】すなわち、ニッケルメッキを行った状態のメッキ皮膜は、非晶質で非磁性であり、熱処理を施すことにより、２５０℃付近から徐々に結晶化し、ＮｉのほかにNi_3Pの共晶体が生じ、磁性も出てくる。また、図７に示すように、４００℃をピークにして硬度も得られる。もっとも、更に高い温度では、一旦微細化した結晶粒が大きくなり硬度も低下する。

【００４３】従って、従来は、無電解メッキを施した界磁用永久磁石を用いる場合は、無電解メッキを施した界磁用永久磁石の熱処理、ロータヨークの回転軸への焼き嵌め挿入及び、その後の界磁用永久磁石のロータヨークのスロットへの挿着という３つの工程を採っているため、工程時間が長くなるとともに、磁石の固定が難しいという問題があった。

【００４４】本発明者等は、前記図７におけるピーク硬

度が３５０～４００℃、とりわけ４００℃で得られることと、回転軸にロータヨークが焼き嵌め挿入されるときの温度が３５０～４００℃であることとの間で、３５０～４００℃が共通することに着想を得て、前記ロータヨークの回転軸への焼き嵌め挿入の際に、併せてニッケルメッキの熱処理を同時に行うことを提案するものである。このように、無電解ニッケルメッキが施された界磁用永久磁石をロータヨークに挿入した後、前記ロータヨークを、ニッケルメッキの熱処理温度とほぼ同一の温度（約４００℃内外）を加えることにより、今まで別工程で行われていたニッケルメッキの熱処理と、焼き嵌め工程とを、同時に行うことを可能としたものである。ニッケルメッキの熱処理と、焼き嵌め工程の一体化により、工程の簡易化及び時間の短縮化が図れるものである。また、本実施例によると、メッキの割れが少なくなったことを確認している。

【００４５】図８は、コンプレッサにロータヨークを挿入する断面図を示している。

【００４６】全体を符号２００で示す冷凍サイクル用コンプレッサは、冷媒が流通する密閉容器２１０を有している。この容器２１０の内部には、圧縮装置（図示を省略）と駆動モータ２２０とが上下直列に配置されている。

【００４７】駆動モータ２２０は、回転子４００、固定子３００及び回転軸２３０とから構成され、前記固定子３００は、固定子鉄芯３１０と励磁用コイル３２０とから構成されている。前記回転子４００は、ロータヨーク、界磁用永久磁石、スペーサｓ及びバランスウエイト１１を一体にしてリベット１３でカシメている。

【００４８】冷凍サイクル用コンプレッサの組み立てに際しては、密閉容器２１０に設置された回転軸２３０に、前述したように、回転子を界磁用永久磁石のキューリー温度以上で、界磁用永久磁石の素材の性能維持温度（電気ニッケルメッキの場合）又はメッキの性能維持温度（無電解ニッケルメッキの場合）のどちらか低い温度の間で数分以内で加熱し、爾後、回転子４００を回転軸２３０に矢印Ｑの方向に挿入し、その後、冷却される。

【００４９】更に、密閉容器２１０の蓋（図示を省略）が閉められ、回転軸２３０を機械的に固定し、励磁コイル３２０に高電流を流し、これにより界磁用永久磁石が着磁され、その後、密閉容器２１０の内部に温風を吹きかけて乾燥させ、内部水分を蒸発させる。

【００５０】上記構成により、ロータの組み立て（界磁用永久磁石のロータヨーク組み込み）と、ロータのコンプレッサの回転軸への組み込みが個別に生産できるようになった。その結果、工程の簡易化及び時間の短縮化が図れる。

【００５１】

【発明の効果】本発明は以上説明したように、ロータヨークの磁極の全磁極又は１つおきの基部に界磁用永久磁石を挿入するようにした永久磁石回転子及びその製造方法であり、電気メッキを施した界磁用永久磁石を用いる場合に、メッキ層が界磁用永久磁石の中央部と端部でほぼ均一でかつ電極跡がなく、しかも工程の簡易化及び製造時間の短縮化を図り得る永久磁石回転子及びその製造方法を得ることができる。

【図面の簡単な説明】

【図１】　本発明の他の実施例に係る永久磁石回転子を分解して示す斜視図である。

【図２】　本発明に用いる界磁用永久磁石を示す図で、（ａ）はその斜視図、（ｂ）はその中央部の断面図、（ｃ）はその端部の断面図である。

【図３】　本発明に用いる電気メッキ装置を示す概念構成図である。

【図４】　磁石に施されるメッキ層の厚みを示す図である。

【図５】　本発明に用いる他の電気メッキ装置を示す概念構成図である。

【図６】　本発明に用いる他の電気メッキ装置を示す概念構成図である。

【図７】　無電解ニッケルメッキの熱処理温度とビッカース硬さとの関係を示す図である。

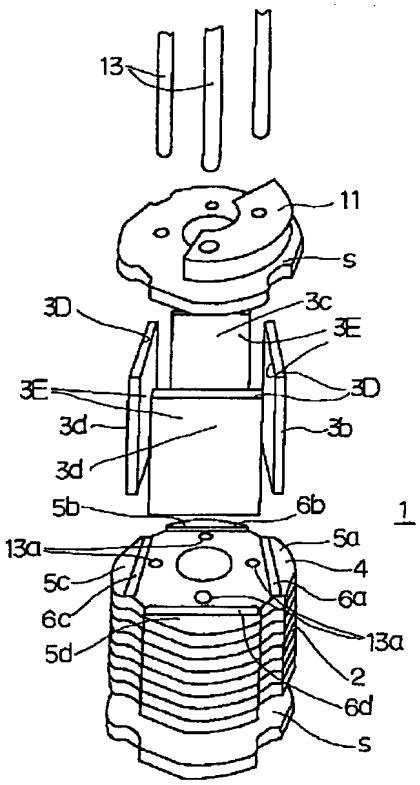
【図８】　コンプレッサに本発明に係る永久磁石回転子のロータヨークを挿入する断面図である。

【図９】　従来の冷凍サイクル用コンプレッサを示す縦断面図である。

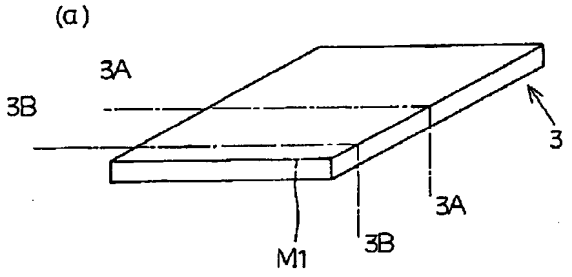
【符号の説明】

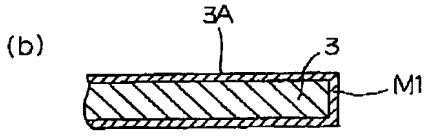
１　永久磁石回転子
２　ロータヨーク
３　界磁用永久磁石
３Ａ　界磁用永久磁石の中央部
３Ｂ　界磁用永久磁石の端部
４　けい素鋼板
５　磁極
６　スロット
Ｍ１　電気ニッケルメッキ

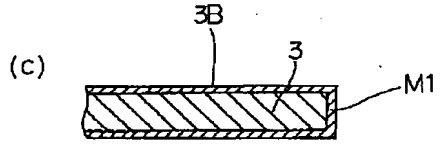
【図１】


13
11
s
3D
3c
3E
3E
3D
3d
3b
3d
5b
6b
1
13a
5a
4
5c
6a
6c
13a
5d
2
6d
s

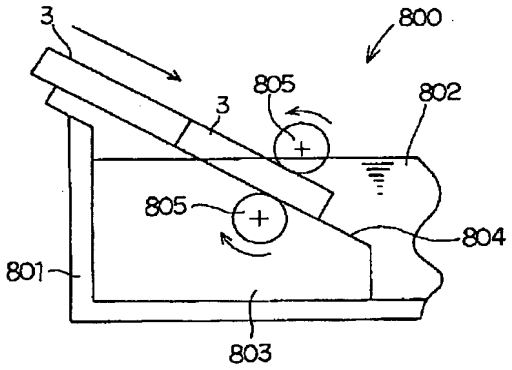
【図２】


(a)
3A
3B
3
3A
M1
3B

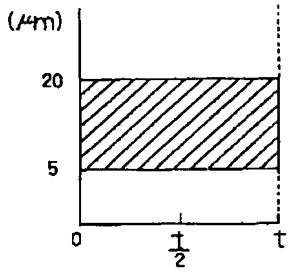

(b)
3A
3
M1


(c)
3B
3
M1

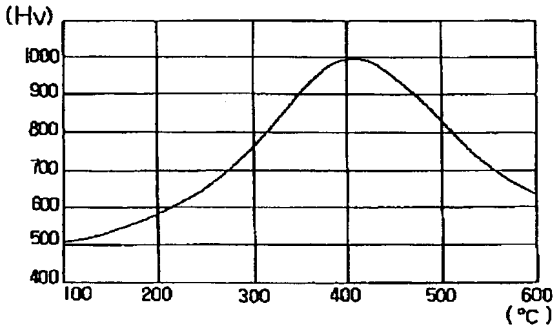
【図３】


3
800
805
3
802
805
804
801
803

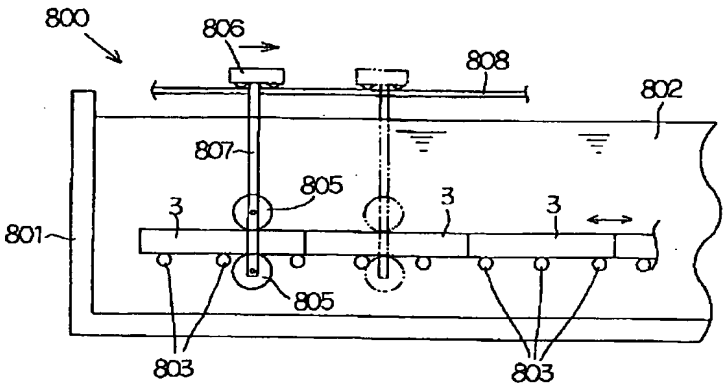
【図４】


(μm)
20
5
0
t/2
t

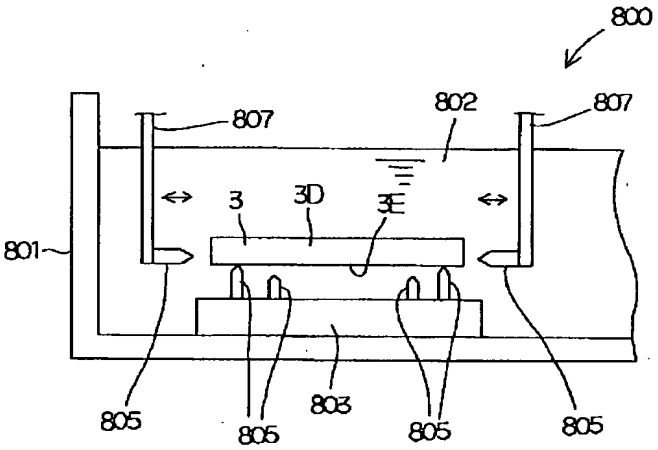
【図７】


(Hv)
1000
900
800
700
600
500
400
100
200
300
400
500
600
(°C)

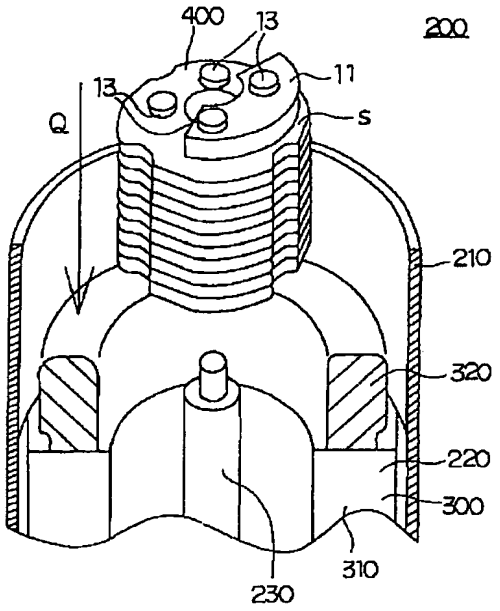
【図５】


800
806
808
802
807
805
3
3
3
801
805
803
803

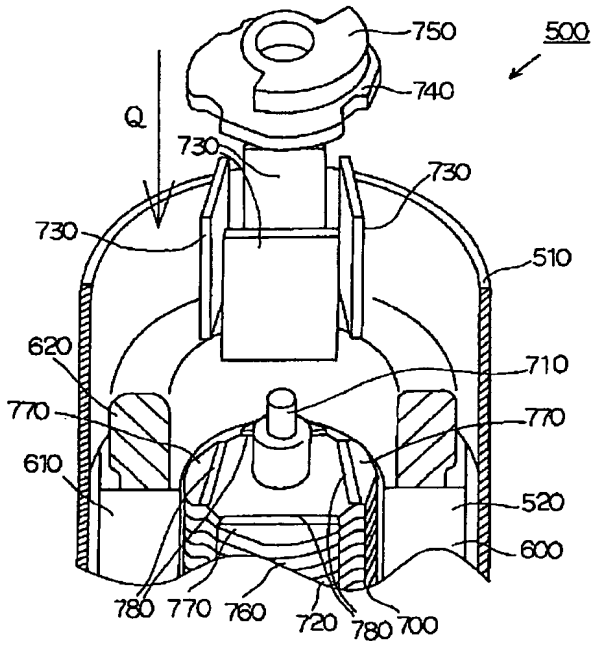
【図６】


800
807
802
807
3
3D
3E
801
805
805
803
805
805

【図８】


400
13
200
13
11
Q
S
210
320
220
300
310
230

【図９】


750
500
740
Q
730
730
730
510
620
710
770
770
610
520
600
780
770
760
720
780
700

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-061261

(43)Date of publication of application : 06.03.2001

(51)Int.Cl. H02K 15/03

C25D 7/00

H02K 1/27

H02K 15/12

(21)Application number : 2000-227099

(22)Date of filing : 31.03.1995

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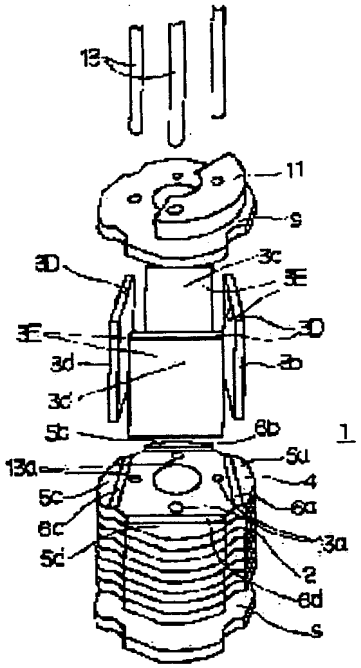
(30)Priority

Priority number	Priority date	Priority country
06120388	01.06.1994	JP
06233224	28.09.1994	JP
06255791	20.10.1994	JP

(54) PERMANENT MAGNET ROTOR AND MANUFACTURE THEREOF



(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a permanent magnet rotor wherein a plated layer is almost uniform in the central part and the end portion of the permanent magnet for a field system and has no trace of electrode, when an electroplated permanent magnet for a field system is used, and moreover can simplify processes and shorten the manufacturing time.

SOLUTION: In this permanent magnet rotor 1, a yoke 2 is formed by laminating many steel sheets 4, having 2n times (n is positive integer) the number of magnetic poles 5 are formed on the outer periphery, slots 6 are formed for all the magnetic poles at equal distances from a rotating shaft hole, or are formed at alternate base parts, and permanent magnets 3 previously electroplated for a field system are inserted in the slots. For the permanent subjected to electroplating, an electrode which is electrically continuous to the permanent magnet is moved relatively to the permanent magnet.

[Claim(s)]

[Claim 1] The yoke of a rotator carries out the laminating of many steel plates, and is formed, and it has a 2n time (n is a positive integer) magnetic pole on a periphery. All the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand said permanent magnet for fields The manufacture approach of the permanent magnet rotator characterized by the electrode which flows in a permanent magnet, and the permanent magnet concerned moving relatively in performing said electroplating.

[Claim 2] The yoke of a rotator carries out the laminating of many steel plates, and is formed, and it has a 2n time (n is a positive integer) magnetic pole on a periphery. All the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand said permanent magnet for fields The manufacture approach of the permanent magnet rotator characterized by making it contact said two or more electrodes alternatively to the permanent magnet concerned while two or more electrodes which flow in a permanent magnet exist in performing said electroplating.

[Claim 3] The yoke of a rotator carries out the laminating of many steel plates, and is formed, and it has a 2n time (n is a positive integer) magnetic pole on a periphery. All the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand After inserting the permanent magnet for fields of rare earth in the slot of the Rota yoke in inserting the Rota yoke in a revolving shaft, The manufacture approach of the permanent

magnet rotator which is beyond the temperature of said curie point of the permanent magnet for fields, inserts this Rota yoke in a revolving shaft, and is characterized by magnetizing after that after heating the Rota yoke between the temperature of under the engine-performance maintenance temperature of the raw material of the permanent magnet for fields.

[Claim 4] The yoke of a rotator carries out the laminating of many steel plates, and is formed, and it has a 2n time (n is a positive integer) magnetic pole on a periphery. All the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand After electroplating which whose thickness of the deposit of said electroplating is almost uniform at the center section and edge of the permanent magnet for fields, and does not have the remains of an electrode was performed to said permanent magnet for fields, The manufacture approach of the permanent magnet rotator characterized by heating the Rota yoke which inserted said permanent magnet for fields to temperature higher than the curie point of said permanent magnet for fields.

[Claim 5] The manufacture approach of the permanent magnet rotator according to claim 1, 2, or 4 characterized by the construction material of said electroplating being nickel plating.

[Claim 6] The yoke of a rotator carries out the laminating of many steel plates, and is formed, and it has a 2n time (n is a positive integer) magnetic pole on a periphery. All the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the permanent magnet rotator which comes to insert the permanent magnet for fields which electroplating is performed beforehand, is among a refrigerant and is used The permanent magnet rotator to which thickness of the deposit of said electroplating is characterized by performing electroplating which is almost uniform at the plate-like center section and plate-like edge of the permanent magnet for fields, and does not have the remains of an electrode to said permanent magnet for fields.

[Claim 7] The permanent magnet rotator according to claim 6 characterized by the construction material of said electroplating being nickel plating.

[Claim 8] The thickness of the deposit of said electroplating is the permanent magnet rotator according to claim 6 to which it is characterized by 5 micrometers or more 20 micrometers or less being [of the permanent magnet for fields] 5 micrometers or more 10 micrometers or less in the center section mostly still more preferably.

[Claim 9] The yoke of a rotator carries out the laminating of many steel plates, and is formed, and it has a 2n time (n is a positive integer) magnetic pole on a periphery. All the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroless nickel plating was given Said permanent magnet for fields is the manufacture approach of the permanent magnet rotator characterized by carrying out after inserting the permanent magnet for fields with which it is a rare earth magnet and said nickel plating was heat-treated in electroless nickel plating in said slot of the Rota yoke.
[Claim 10] The manufacture approach of a permanent magnet rotator according to claim 9 that said heat treatment temperature is characterized by being 350-400 degrees C.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the permanent magnet rotator which inserted the permanent magnet for fields in all the magnetic poles of the magnetic pole of the Rota yoke, or the base in every other one, and its manufacture approach.
[0002]
[Description of the Prior Art] Generally, in the compressor, a drive motor and a compression equipment are arranged in serial inside the well-closed container with which a refrigerant and oil circulate, and the technique in which the permanent magnet for fields is inserted in the rotator of said drive motor is known.
[0003] Drawing 9 shows the longitudinal section of the conventional compressor for refrigerating cycles. The compressor for refrigerating cycles in which the whole is shown with a sign 500 has the well-closed container 510 with which a refrigerant circulates. Inside this container 510, the compression equipment (a graphic display is omitted) and the drive motor 520 are arranged at the vertical serial.
[0004] The drive motor 520 consists of a rotator 700, a stator 600, and a revolving shaft 710. Said stator 600 consists of a stator core 610 and a coil 620 for excitation. Said rotator 700 has the Rota yoke 720, the permanent magnet 730 for fields, the spacer 740, and the balance weight 750. The Rota yoke 720 is formed by carrying out the laminating of many silicon steel plates 760. The magnetic pole 770 is formed in the periphery of the Rota yoke 720, and the slot 780 which inserts the permanent magnet 730 for fields is formed in the base of this magnetic pole 770.

[0005] The permanent magnet 730 for fields is formed in the magnitude which can be held in a slot 780, and, generally surface treatment is not performed to the front face of the permanent magnet for fields.

[0006] The Rota yoke 720 is inserted [it burns it and] in and inserted in the revolving shaft 710 beforehand installed in the well-closed container 510 on the occasion of the assembly of the compressor for refrigerating cycles. That is, the Rota yoke 720 is heated at about 450 degrees C, and a central revolving-shaft hole is expanded, and a little, a major diameter, nothing, and while it has been hot, it inserts in a revolving shaft 710. When the Rota yoke 720 cools after that, the revolving-shaft hole which was expanding will contract and the breakthrough concerned will carry out binding maintenance of the revolving shaft 710. In addition, at the time of a compressor activity, although the temperature of the compressor itself rises and being amounted to about 130 degrees C, since a revolving shaft 710 also expands simultaneously in this case, the maintenance of the Rota yoke 720 to a revolving shaft 710 is not reduced.

[0007] And the permanent magnet 730 for fields is inserted in the Rota yoke 720. That is, the permanent magnet 730 for fields with which surface treatment is not carried out after cooling of the Rota yoke 710 by no magnetizing [which was wrapped in rust-proofing paper] is inserted in the interior of a slot 780. Furthermore, the nonmagnetic spacer 740 is pressed fit to the edge of the Rota yoke 720 as immobilization of the shaft orientations of the permanent magnet for fields after insertion of the permanent magnet 730 for fields, and, subsequently the magnetic balance weight 750 which maintains the ** balance of a compression equipment is pressed fit to near the spacer 740 edge. The drawing Nakaya mark Q shows the path of insertion of the permanent magnet 730 for fields.

[0008] After said each part article is inserted, the lid (a graphic display is omitted) of a well-closed container 510 is shut, and in a high current, a sink and a revolving shaft 710 are locked in the coil 620 for excitation, the permanent magnet 730 for fields is magnetized, after that, warm air is blown upon the interior of a well-closed container 510, it is dried, and internal moisture is evaporated.

[0009]

[Problem(s) to be Solved by the Invention] Since it is what inserts in the slot of the Rota yoke the permanent magnet for fields with which surface treatment is not carried out according to the conventional technique mentioned above, Since a motor operates in the pressurized container which management of generating prevention of rust until it incorporates the permanent magnet for fields is as serious as except, and a refrigerant and oil are pressurized also even for after slot insertion, and circulates A refrigerant and

oil permeated to the interior of the raw material of the permanent magnet for fields, and there was a problem in which a magnet is dissolved. Then, that by which surface treatment is made by the permanent magnet for fields used for a compressor is known recently. Although insert the 2nd page with the needlelike fixed electrode whose magnet item counters, a current is passed to this, it is immersed in a plating bath and nickel plating is performed, in order that plating may not attach the surface treatment in this case to the part which the fixed electrode of a magnet raw material front face touched, a magnet raw material is exposed.

[0010] When inserting in the slot of the Rota yoke the permanent magnet for fields with which such electric nickel plating was performed, in order to prevent that rust is generated from the remains of an electrode, even if it needed to apply remedy material to the remains of an electrode (nickel plating with the remains of an electrode calls hereafter what applied remedy material to the remains of an electrode.) and performed still such remedy, there was a problem which remedy material solves in a refrigerant or oil. In addition, the dimensional control of the magnet which it burns and inserts in, and is easy to produce peeling of remedy material by the difference in the expansion coefficient of remedy material and plating to the elevated temperature of warm air desiccation, and lowering of strength in high temperature also has by the difference in construction material, and includes the remedy section was also serious.

[0011] Furthermore, for the fixed electrode, plating current concentrated on the edge of the permanent magnet for fields, and nickel plating with the remains of an electrode had the inclination (increase of 20-micrometer - 50micrometer) for an edge to become thicker than a center section generally, therefore since the residual stress in the film would increase if the plating film becomes thick while a dimensional control is difficult, it had the inconvenience to which the adhesion force also falls.

[0012] On the other hand, not using the permanent magnet for fields which performed electroplating mentioned above, what inserts in the Rota yoke the permanent magnet for fields which performed electroless deposition exists. In this case, the permanent magnet for fields which performed electroless deposition was heat-treated separately, and after burning, inserting in and inserting the Rota yoke in a revolving shaft, the permanent magnet for fields after heat treatment is inserted in the slot of the Rota yoke. When using the permanent magnet for fields which performed such electroless deposition, since three processes of [burn and insert in and] insertion and insertion into the slot of the Rota yoke of the subsequent permanent magnet for fields to heat treatment of the permanent magnet for fields which performed electroless deposition, and the revolving shaft of the Rota yoke are taken, while process time amount becomes

long, there is a problem that magnetic immobilization is difficult.

[0013] This invention improves the permanent magnet rotator by which the permanent magnet for fields which performed electroplating, and the permanent magnet for fields which performed electroless deposition are inserted in the slot of the Rota yoke, and its manufacture approach. When using the permanent magnet for fields which performed electroplating it is in acquiring the permanent magnet rotator using the permanent magnet for fields which a deposit is almost uniform at the center section and edge of the permanent magnet for fields, and there are no remains of an electrode, and performed electroless deposition which can attain simplification of a process, and shortening of production time together, and its manufacture approach.

[0014]

[Means for Solving the Problem] The yoke of a rotator carries out the laminating of many steel plates, and invention according to claim 1 is formed. It has a 2n time (n is a positive integer) magnetic pole on a periphery, and all the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In performing said electroplating, in the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand, said permanent magnet for fields is the manufacture approach of the permanent magnet rotator which the electrode which flows in a permanent magnet, and the permanent magnet concerned move relatively.

[0015] The yoke of a rotator carries out the laminating of many steel plates, and invention according to claim 2 is formed. It has a 2n time (n is a positive integer) magnetic pole on a periphery, and all the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand said permanent magnet for fields While two or more electrodes which flow in a permanent magnet exist in performing said electroplating, it is the manufacture approach of a permanent magnet rotator of having made it contact said two or more electrodes alternatively to the permanent magnet concerned.

[0016] The yoke of a rotator carries out the laminating of many steel plates, and invention according to claim 3 is formed. It has a 2n time (n is a positive integer) magnetic pole on a periphery, and all the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to

insert the permanent magnet for fields with which electroplating was performed beforehand After inserting the permanent magnet for fields of rare earth in the slot of the Rota yoke in inserting the Rota yoke in a revolving shaft, It is beyond the temperature of said curie point of the permanent magnet for fields, and after heating the Rota yoke between the temperature of under the engine-performance maintenance temperature of the raw material of the permanent magnet for fields, it is the manufacture approach of the permanent magnet rotator which inserts this Rota yoke in a revolving shaft, and is magnetized after that.

[0017] The yoke of a rotator carries out the laminating of many steel plates, and invention according to claim 4 is formed. It has a 2n time (n is a positive integer) magnetic pole on a periphery, and all the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroplating was performed beforehand After electroplating which whose thickness of the deposit of said electroplating is almost uniform at the center section and edge of the permanent magnet for fields, and does not have the remains of an electrode was performed to said permanent magnet for fields, It is the manufacture approach of a permanent magnet rotator of having heated the Rota yoke which inserted said permanent magnet for fields to temperature higher than the curie point of said permanent magnet for fields.

[0018] Invention according to claim 5 is the manufacture approach of a permanent magnet rotator that the construction material of said electroplating is nickel plating, in claims 1 and 2 or invention of 4.

[0019] The yoke of a rotator carries out the laminating of many steel plates, and invention according to claim 6 is formed. It has a 2n time (n is a positive integer) magnetic pole on a periphery, and all the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the permanent magnet rotator which comes to insert the permanent magnet for fields which electroplating is performed beforehand, is among a refrigerant and is used The thickness of the deposit of said electroplating is almost uniform at the plate-like center section and plate-like edge of the permanent magnet for fields, and is the permanent magnet rotator by which electroplating without the remains of an electrode is performed to said permanent magnet for fields.

[0020] Invention according to claim 7 is a permanent magnet rotator whose construction material of said electroplating is nickel plating in invention of claim 6.

[0021] For invention according to claim 8, in invention of claim 6, the permanent

magnet for fields is a center section mostly, and 5 micrometers or more 20 micrometers or less of thickness of the deposit of said electroplating are 5-micrometer or more permanent magnet rotator which is 10 micrometers or less still more preferably.

[0022] The yoke of a rotator carries out the laminating of many steel plates, and invention according to claim 9 is formed. It has a 2n time (n is a positive integer) magnetic pole on a periphery, and all the magnetic poles of an almost equal distance or the base in every other one is equipped with a slot from a revolving-shaft hole. Into this slot In the manufacture approach of the permanent magnet rotator which comes to insert the permanent magnet for fields with which electroless nickel plating was given Said permanent magnet for fields is a rare earth magnet, and is the manufacture approach of the permanent magnet rotator performed after inserting the permanent magnet for fields with which said nickel plating was heat-treated in electroless nickel plating in said slot of the Rota yoke.

[0023] Invention according to claim 10 is the manufacture approach of a permanent magnet rotator that said heat treatment temperature is 350-400 degrees C, in invention of claim 9.

[0024]

[Embodiment of the Invention] Hereafter, the example of this invention is explained with reference to an attached drawing.

[0025] Drawing 1 is the exploded view showing the permanent magnet rotator concerning the example of this invention. The permanent magnet rotator 1 of this example has the Rota yoke 2 by which the laminating was carried out to the shape of a column, and two pairs of tabular permanent magnets 3 (3a, 3b, 3c, 3d) for fields. Said Rota yoke 2 extracts many silicon steel plates 4 with metal mold, and the laminating of it is carried out to one, and it is formed in it. The Rota yoke 2 has four magnetic poles 5 (5a, 5b, 5c, 5d) which projected in the radiation direction in the peripheral face. The slot 6 (6a, 6b, 6c, 6d) in which the permanent magnet for fields is made to insert is formed in the base of these magnetic poles. Furthermore, the revolving-shaft hole which makes a revolving shaft penetrate is prepared in the core of the Rota yoke 2. Moreover, rivet breakthrough 13a for immobilization of the shaft orientations of the permanent magnet for fields is prepared between the minimum distances of a slot and a revolving-shaft hole.

[0026] As shown in (a) of drawing 2 , the permanent magnets 3a, 3b, 3c, and 3d for fields were formed in six face pieces of a cross-section rectangle, and have performed electric nickel plating M1 to the front face of the permanent magnet for fields. Plating is performed by plating means to mention this electric nickel plating M1 later.

[0027] Furthermore, insert the permanent magnet 3 for fields in a slot 6, the nonmagnetic spacer s is made to install in the ends of the Rota yoke 2 as immobilization of the shaft orientations of the permanent magnet for fields concerned, the balance weight 11 which maintains the ** balance of a compression equipment is put, finally the Rota yoke 2, Spacer s, and a balance weight 11 are summarized, and the whole is fixed in total by the rivet 13. Thereby, the permanent magnet rotator 1 of this example is assembled.

[0028] In this invention, said electric nickel plating has the almost uniform coat thickness of plating at center-section 3A of the permanent magnet 3 for fields shown in (b) of drawing 2 , and edge 3B shown in (c) of drawing 2 , and is electroplating without the remains of an electrode.

[0029] Plating is performed as such electric nickel plating M1 is shown in drawing 3 . That is, in the container 801 filled up with the solution 802, that top face installs the fixture 803 which makes an inclined plane 804, arranges the spherical electrode 805,805 of a couple near this fixture 803, and constitutes a gilding machine 800. If a magnet 3 is set to said inclined plane 804 and sent to a slanting lower part, while a magnet 3 will be pinched by the electrode 805,805 within a solution 802, the electrode concerned rotates and a magnet 3 is sent further caudad. An electrode 805,805 holds the location of **** to rotate, a plating power source flows in this electrode 805,805, and electric nickel plating is made by the magnet 3. Since the electrode location of a magnet 3 changes at this time, nickel plating can be uniformly performed to the front face of a magnet 3. Furthermore, since the electrode is spherical, it becomes point contact to a magnet and producing variation in plating thickness decreases.

[0030] According to an artificer's etc. experiment, by moving an electrode and performing electric nickel plating, as mentioned above, center-section 3A and edge 3B of the permanent magnet 3 for fields are almost uniform, and it is checking that electroplating without the remains of an electrode is obtained. In the permanent magnet for fields holding the corner of an acute angle, the corner was especially able to plate in accordance with the configuration of a magnet raw material to homogeneity, without becoming round. In addition, it is because it becomes the front face to which a crack cannot be attached easily that considering as nickel plating by this example can obtain the deposit of a high degree of hardness by this, and it is hard to wear out. But as for this invention, it is needless to say that it is not what is restricted to nickel plating.

[0031] In this example, as shown in drawing 4 , 5-20 micrometers of a deposit are desirable. Furthermore, especially a desirable thing is 5-10 micrometers. In drawing 4 , an axis of abscissa is spacing of a magnetic longitudinal direction, t is an edge, and t/2 is

a center section, and the axis of ordinate shows the thickness of a deposit.
[0032] The deposit given to the permanent magnet for fields is so good that it is thin. The gap between the permanent magnet for fields and a silicon steel plate will become large, the effectiveness of magnetic flux will worsen, and this will produce the crack of a deposit, and peeling with thermal expansion or thermal stress, if a deposit becomes thick. Since there can be little this point and thermal stress which the one where a deposit is thinner receives, can end and can make distortion small, the thinner one is good. However, in the case of the motor which reinforcement [as opposed to / that it is less than 5 micrometers / an oscillation] runs short, for example, is used for a compressor, the inconvenience in which a deposit separates in the operating range (-20-130 degrees C) of a compressor is produced. On the other hand, if it exceeds 20 micrometers, it will have become clear that the crack of a deposit and peeling are produced with thermal expansion or thermal stress. Therefore, as mentioned above, 5-20 micrometers of a deposit are desirable. When a deposit is set to 5-10 micrometers, even if it carries out forced cooling of the magnet after compressor inclusion, the crack of a deposit is not especially produced. When not carrying out forced cooling, it is good at 5-20 micrometers.
[0033] Drawing 5 is drawing showing other electric gilding machines used for this invention, and in the case of this example, the roller-like fixture 803,803 is installed in the container 801 filled up with the solution 802, it arranges the electrode 805,805 of the shape of a roll of a movable couple in a longitudinal direction along with this fixture 803, and constitutes a gilding machine 800. The electrode 805,805 is formed in the longitudinal direction movable through the support lever 807 at the slider 806. It is immersed in a solution 802, and a magnet 3 is laid in said fixture 803,803, and is pinched by the electrode 805,805. In this example, an electrode 805,805 rotates, it moves to a longitudinal direction, and electric nickel plating is made by the magnet 3. Since the electrode location of a magnet 3 changes also in this example, nickel plating can be uniformly performed to the front face of a magnet 3. Moreover, since the roller-like fixture 803,803 will produce the part where plating is not made if it contacts in the always same location in case this lays a magnet 3, the roller-like fixture 803,803 is made as [carry out / some / forward reverse rotation]. By this, it will be given, without nickel plating being almost uniform on the front face of a magnet 3, and attaching the remains of an electrode, when a magnet 3 is rocked to a longitudinal direction and the electrode location to the magnet of said electrode 805,805 changes.
[0034] In the case of this example, drawing 6 is drawing showing the electric gilding machine of further others used for this invention, in the container 801 filled up with the

solution 802, the fixture 803 which formed two or more movable electrodes 805,805 is installed in the vertical direction, an electrode 805 protrudes and a gilding machine 800 is constituted in the lower part of the support lever 807 movable in another side and a longitudinal direction. It is immersed in a solution 802 and a magnet 3 is laid in said fixture 803,803. In this example It is made for the electrode 805 which the electrode 805 prepared in the fixture 803 contacted field 3E which has the large surface area of a magnet 3, and was prepared in the support lever 807 to contact field 3D which has the small surface area of a magnet 3. When either of each electrode 805,805 flows with a magnet, electric nickel plating is made by the magnet 3. That is, in this example, since the electrode location of a magnet 3 changes by achieving contact and a flow with an electrode and a magnet alternatively suitably, it is made as [perform / uniformly / to the front face of a magnet 3 / nickel plating].

[0035] Thus, in this invention, since a magnet and an electrode move relatively, in the case of electroplating, the surface treatment which concentration of the current over a magnet is lost and does not produce the remains of an electrode is made, and it can plate to homogeneity at a center section and the edge. Furthermore, since it is the configuration which an electrode moves, the corner concerned can form a deposit in homogeneity in accordance with the configuration of a magnet raw material also to the permanent magnet for fields equipped with the corner of an acute angle, without becoming round.

[0036] Therefore, when the electrode remedy section is in an order end face according to the conventional electroplating When it is in field 3E in which the die length of the shaft orientations of the Rota yoke 2 and a magnet was not able to be identically set, and the electrode remedy section has magnetic large surface area Since there is no lobe of the electrode remedy section like before in the permanent magnet 3 for fields to there having been inconvenience to which the gap between the permanent magnet for fields and a silicon steel plate must be enlarged, therefore the effectiveness of magnetic flux worsens according to this invention, Such inconvenience can be avoided, consequently a dimensional control can be easily performed now.

[0037] Next, as for the permanent magnet rotator 1 of assembled this example, heating is made less than several minutes from the curie point of the permanent magnet 3 for fields between which of the engine-performance maintenance temperature of plating, or the engine-performance maintenance temperature of the raw material of the permanent magnet for fields, or low temperature. As everyone knows, although it has the spontaneous MAG in itself, this spontaneous MAG aligns by impression of an external magnetic field and ferromagnetics, such as a magnet, express the MAG outside, the

temperature to which this spontaneous MAG disappears is called curie point.
[0038] In this example, it is beyond the temperature of said curie point of the permanent magnet for fields, and after heating the permanent magnet rotator 1 several minutes between the temperature of under the engine-performance maintenance temperature of the raw material of the permanent magnet for fields, this rotator 1 is inserted in the revolving shaft of the compressor for refrigerating cycles so that it may mention later.
[0039] According to this example explained above, in the case of electroplating, the surface treatment which concentration of the current over a magnet is lost and does not produce the remains of an electrode is made, and it can plate to homogeneity at a center section and the edge. Furthermore, since it is the configuration which an electrode moves, the corner concerned can form a deposit in homogeneity in accordance with the configuration of a magnet raw material also to the permanent magnet for fields equipped with the corner of an acute angle, without becoming round. Since especially corner 3C was held by own reinforcement of plating, its need for raw material reinforcement of a permanent magnet own [for fields] decreased. Moreover, mostly, in center-section 3A, the thickness of the electric nickel plating M1 is demagnetized at high temperature after inserting the thickness of 20 micrometers or less of 5 micrometers or more, nothing, and the permanent magnet 3 for fields in the Rota yoke 2, even if the magnet slightly magnetized by [of the permanent magnet for fields] burning, inserting in and carrying out at temperature higher than the curie point of the permanent magnet for fields is mixing. Furthermore, by applying an elevated temperature, that the bonding strength of the interface of plating and the permanent magnet for fields improves is also the knowledge which this invention person etc. acquired newly. Moreover, when a rotator was inserted in a revolving shaft, while 5-micrometer or more thickness of 20 micrometers or less was the minimum plating thickness which the distortion or the crack by the difference in the expansion coefficient of the permanent magnet for fields and plating cannot generate easily, it also became clear that peeling of plating by oscillation could be prevented after inserting in the slot of the Rota yoke 2. Especially a desirable thing is considering as the thickness of 5-10 micrometers, and as mentioned above, it does not produce a plating crack with forced cooling. Furthermore, since the construction material of electroplating is nickel plating, it is harder than a magnetic raw material, and since it has the property of soft magnetism, endurance ability also improves that a crack cannot be easily attached to the Rota yoke before and after insertion. Moreover, even if plating separates after inclusion, since plating is the magnetic substance, it will be adsorbed and will not disperse from a magnet raw material front face. Furthermore, in the rotator which

inserts the permanent magnet for fields in the slot of the Rota yoke like this example, since it is electroplating of the magnetic substance, it is also a big advantage that magnetic GYAPU of a slot and the permanent magnet for fields can be set up few.
[0040] Moreover, the following example is consulted when using a rare earth magnet for the permanent magnet for fields. That is, after inserting the permanent magnet for fields of rare earth in the slot of the Rota yoke, it is beyond the temperature of said curie point of the permanent magnet for fields, and after heating the permanent magnet rotator 1 several minutes between the temperature of under the engine-performance maintenance temperature of the raw material of the permanent magnet for fields, this rotator 1 is inserted in a revolving shaft, and after that, it magnetizes and goes into predrying temperature (before or after 170 degrees C). In this point and the former, carrying out the temperature rise of the permanent magnet for fields at the time of a motor activity, and demagnetizing the first stage is known. However, if dissipation (demagnetization) of the spontaneous MAG is made in case [of the revolving shaft of said Rota yoke / so-called] it burns and inserts in, and it passes through the process of subsequent magnetization and predrying, even if in the case of a rare earth magnet a motor will be used in the future and it will be exposed in predrying temperature, it has become clear that the situation of the initial demagnetization mentioned above is avoidable.
[0041] By the way, electroless deposition besides [which mentioned nickel plating above] electroplating is also known. And in the former, that by which the permanent magnet for fields with which electroless nickel plating was given is inserted in the slot of the Rota yoke is also used. In this case, nickel plating is heat-treated before inserting the permanent magnet for fields which performed nickel plating in the Rota yoke.
[0042] That is, the plating coat in the condition of having performed nickel plating is amorphous, and it is nonmagnetic, and by heat-treating, it crystallizes gradually from near 250 degree C, the eutectic object of nickel3-P other than nickel arises, and magnetism also comes out. Moreover, as shown in drawing 7 , a degree of hardness is also obtained with a peak of 400 degrees C. But at still higher temperature, the crystal grain once made detailed becomes large, and a degree of hardness also falls.
[0043] Therefore, when the permanent magnet for fields which performed electroless deposition was used conventionally, since three processes of [burn and insert in and] insertion and insertion into the slot of the Rota yoke of the subsequent permanent magnet for fields to heat treatment of the permanent magnet for fields which performed electroless deposition, and the revolving shaft of the Rota yoke were taken, while process time amount became long, there was a problem that magnetic immobilization

was difficult.

[0044] Between that 350-400 degrees C of peak degrees of hardness in said drawing 7 are especially obtained at 400 degrees C, and temperature in case the Rota yoke is inserted [it burns it and] in and inserted in a revolving shaft being 350-400 degrees C, this invention person etc. gets an idea for 350-400 degrees C to be common, and proposes the thing to the revolving shaft of said Rota yoke for which it burns and inserts in and nickel plating is collectively heat-treated simultaneously in the case of insertion. Thus, after inserting in the Rota yoke the permanent magnet for fields with which electroless nickel plating was given, it makes it possible to burn and insert in said Rota yoke with heat treatment of nickel plating performed at another process until now by applying the almost same temperature (the inside and outside of about 400 degree C) as the heat treatment temperature of nickel plating, and to perform a process simultaneously. It burns and inserts in with heat treatment of nickel plating, and simplification of a process and shortening of time amount can be attained by unification of a process. Moreover, according to this example, it is checking that the crack of plating has decreased.

[0045] Drawing 8 shows the sectional view which inserts the Rota yoke to the compressor.

[0046] The compressor for refrigerating cycles in which the whole is shown with a sign 200 has the well-closed container 210 with which a refrigerant circulates. Inside this container 210, the compression equipment (a graphic display is omitted) and the drive motor 220 are arranged at the vertical serial.

[0047] A drive motor 220 consists of a rotator 400, a stator 300, and a revolving shaft 230, and said stator 300 consists of a stator iron core 310 and a coil 320 for excitation. Said rotator 400 makes one the Rota yoke, the permanent magnet for fields, Spacer s, and a balance weight 11, is a rivet 13, and is caulking ******.

[0048] The assembly of the compressor for refrigerating cycles is faced. As mentioned above in the revolving shaft 230 installed in the well-closed container 210, a rotator above the curie temperature of the permanent magnet for fields either the engine-performance maintenance temperature (in the case of electric nickel plating) of the raw material of the permanent magnet for fields, or the engine-performance maintenance temperature (in the case of electroless nickel plating) of plating -- it heats within several minutes between low temperature, a rotator 400 is inserted in a revolving shaft 230 in the direction of an arrow head Q since then, and it is cooled after that.

[0049] Furthermore, the lid (a graphic display is omitted) of a well-closed container 210

is shut, a revolving shaft 230 is fixed mechanically, a high current is passed to an exiting coil 320, the permanent magnet for fields is magnetized by this, after that, warm air is blown upon the interior of a well-closed container 210, it is dried, and internal moisture is evaporated.

[0050] By the above-mentioned configuration, the inclusion to the revolving shaft of the assembly (the Rota yoke inclusion of the permanent magnet for fields) of Rota and the compressor of Rota can produce now according to an individual. Consequently, simplification of a process and shortening of time amount can be attained.

[0051]

[Effect of the Invention] As explained above, when using the permanent magnet for fields which are the permanent magnet rotator which inserted the permanent magnet for fields in all the magnetic poles of the magnetic pole of the Rota yoke, or the base in every other one, and its manufacture approach, and performed electroplating, the deposit of this invention is almost uniform at the center section and edge of the permanent magnet for fields, and it does not have the remains of an electrode, and can acquire the permanent magnet rotator which can moreover attain simplification of a process, and shortening of production time, and its manufacture approach.

[Brief Description of the Drawings]

[Drawing 1] It is the perspective view decomposing and showing the permanent magnet rotator concerning other examples of this invention.

[Drawing 2] It is drawing showing the permanent magnet for fields used for this invention, and (a) is [the sectional view of the center section and (c of the perspective view and (b))] the sectional views of the edge.

[Drawing 3] It is the conceptual block diagram showing the electric gilding machine used for this invention.

[Drawing 4] It is drawing showing the thickness of the deposit given to a magnet.

[Drawing 5] It is the conceptual block diagram showing other electric gilding machines used for this invention.

[Drawing 6] It is the conceptual block diagram showing other electric gilding machines used for this invention.

[Drawing 7] It is drawing showing the relation between the heat treatment temperature of electroless nickel plating, and Vickers hardness number.

[Drawing 8] It is the sectional view which inserts the Rota yoke of the permanent magnet rotator concerning this invention in a compressor.

[Drawing 9] It is drawing of longitudinal section showing the conventional compressor

for refrigerating cycles.

[Description of Notations]

1 Permanent Magnet Rotator

2 Rota Yoke

3 Permanent Magnet for Fields

3A The center section of the permanent magnet for fields

3B The edge of the permanent magnet for fields

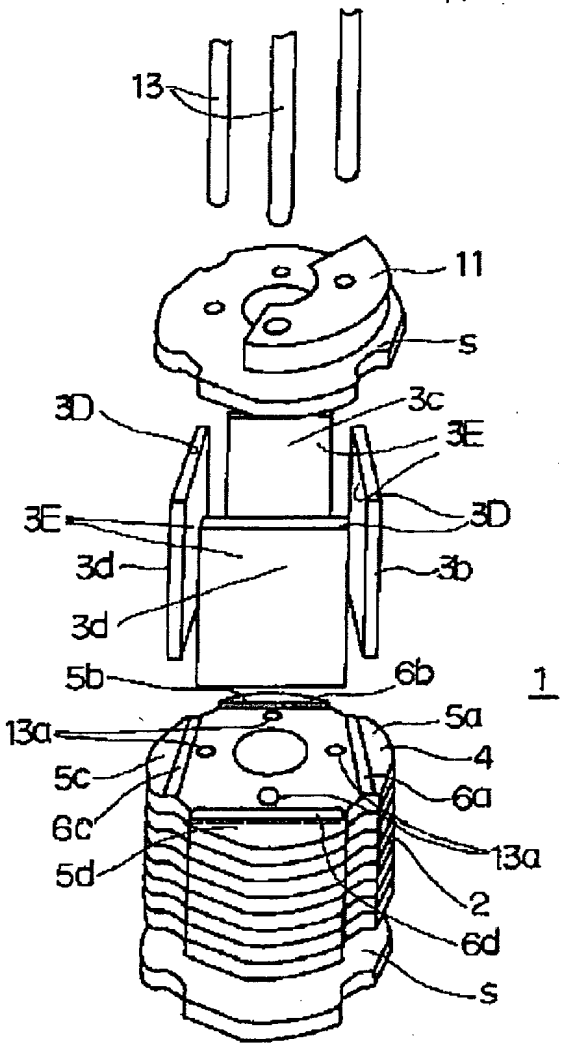
4 Silicon Steel Plate

5 Magnetic Pole

6 Slot

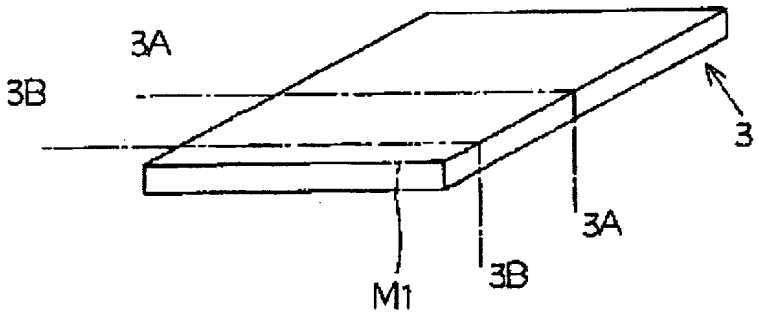
M1 Electric nickel plating

Drawing 1]

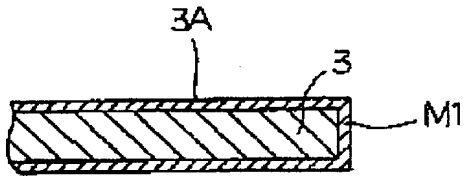


Drawing 2]

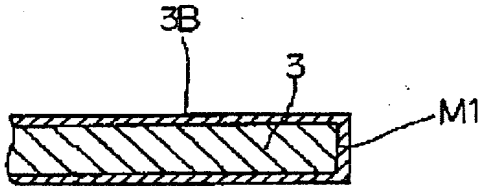
(a)



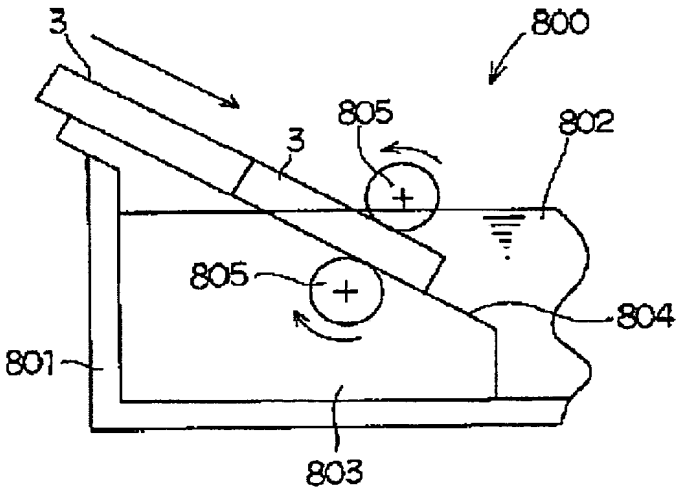
(b)



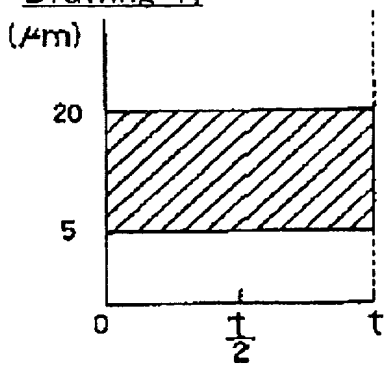
(c)



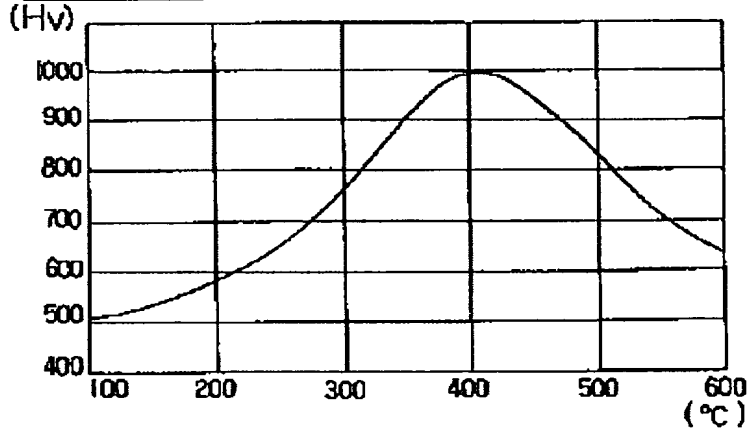
Drawing 3]



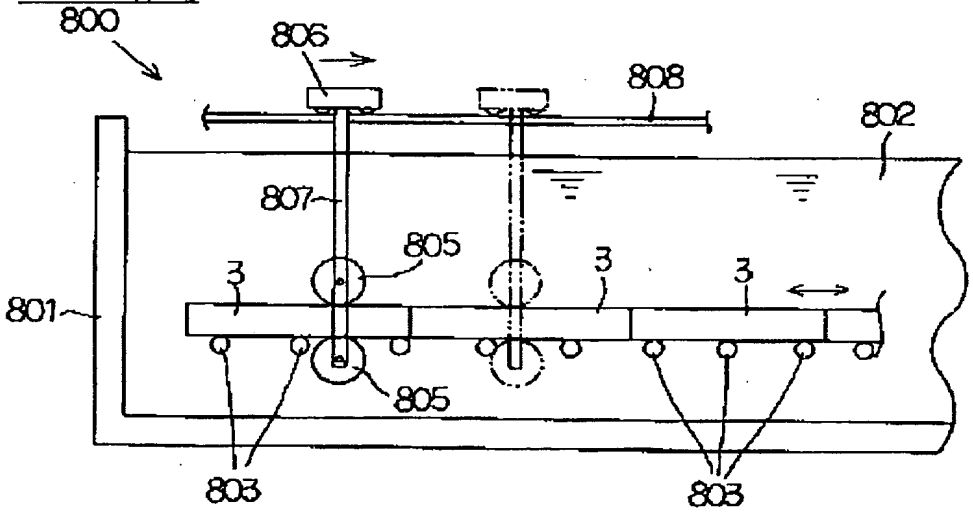
Drawing 4]



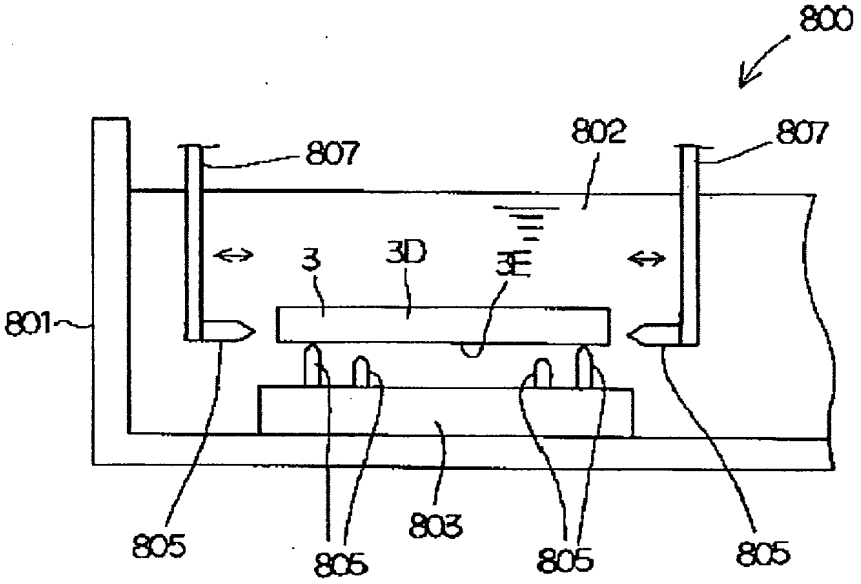
Drawing 7]



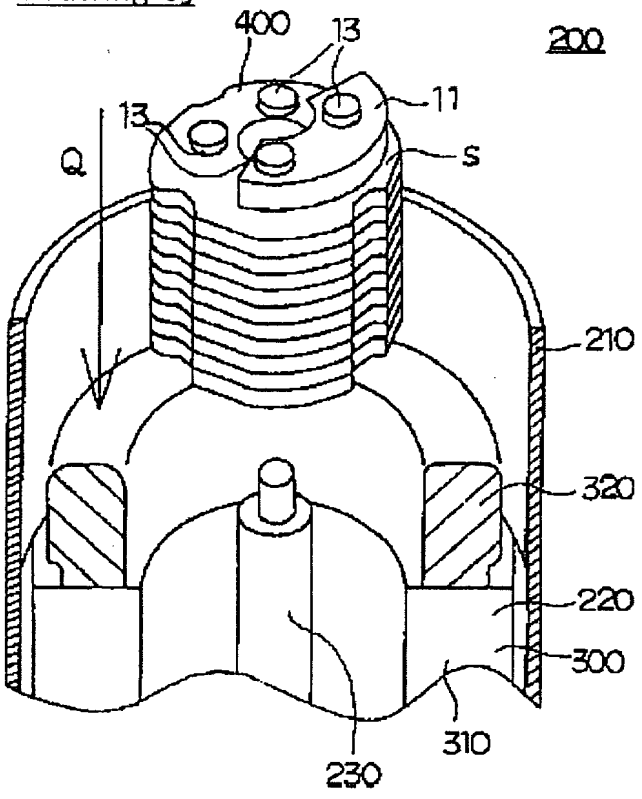
Drawing 5]



Drawing 6]



Drawing 8]



Drawing 9]